A GEOCHEMICAL AND ISOTOPIC VIEW OF THE FORMATION AND EVOLUTION OF BENNU'S PARENT BODY.

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Introduction: NASA's Origins, Spectral Interpretation, Resource Identification, and Security–Regolith Explorer (OSIRIS-REx) mission surveyed the asteroid (101955) Bennu from 2018 to 2021 and delivered 121.6 g of its regolith to Earth in September 2024[1,2]. Bennu is a rubble pile, consisting of reaccumulated fragments of a much larger parent body (≥100 km) that was collisionally disrupted in the main asteroid belt[3]. Remote sensing by the OSIRIS-REx spacecraft (e.g.,[4-5]), together with early laboratory analyses of the regolith samples,[1] showed that Bennu's surface material is composed of hydrated phyllosilicates, magnetite, sulfides, carbonates, organic compounds, and minor amounts of anhydrous silicates and oxides.

Methods: We, the Sample Elements and Isotopes Working Group (SEIWG) of the OSIRIS-REx Sample Analysis Team, used a variety of analytical techniques to determine the bulk and in situ elemental and isotopic compositions of aggregate samples from Bennu. We used the data obtained to characterize the reservoir from which Bennu's precursor formed, the diversity of material it accreted, and the extent to which that material was altered.

Results & Discussion: We find that Bennu comprises components sourced from inner, outer, and extra–solar system origins[6]. Though Bennu's composition is like that of other primitive astromaterials, including asteroid Ryugu and Ivuna-type (CI) carbonaceous chondrites, it is richer in the light isotopes of Zn and K, and contains a greater abundance of anhydrous silicates and isotopically anomalous organic matter[6]. Our findings suggest that the Bennu samples analyzed to date represent an intermediate degree of alteration: less than that of CIs and Ryugu but greater than that of other primitive carbonaceous chondrites[6]. We propose that the parent bodies of Bennu, Ryugu, and CIs formed from a shared but heterogeneous reservoir of presolar grains, organic matter, refractory inclusions, anhydrous silicates, and ices in the outer parts of the protoplanetary disk[6].

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